Comparison of the sensitivity of Australasian and non-Australasian aquatic organisms to selected metals

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CERTIFICATE OF AUTHORSHIP/ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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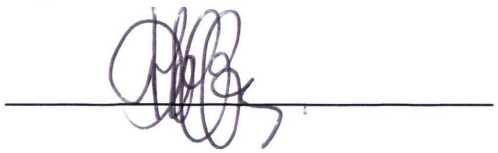

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ABSTRACT

The difference in sensitivity of Australasian species and their non-Australasian counterparts has not been thoroughly examined. Of those studies that have been undertaken, there was no clear pattern evident regarding which group of species was the most sensitive. The current study aimed to determine if there were any significant differences between the sensitivity of organisms from these two regions by collating metal toxicity data and determining if significant differences were evident using Student t-tests and species sensitivity distribution (SSD) methods. Generally, there was more non-Australasian toxicity data available than Australasian data. Therefore, the availability of sufficient toxicity data for Australasian species determined which metals could be investigated. The metals for which there was sufficient data were As(III), As(V), Cd, Cr(VI), Cu, Pb, Hg, U and Zn for freshwater organisms and Cd, Cr(VI), Cu, Pb, Hg, Ni, and Zn for marine/estuarine organisms. Data was assessed using quality assessment criteria that were tested and improved as part of this study. The quality of the toxicity data was assessed in order to ensure that only acceptable quality data were used in the comparisons. Statistical comparisons of the best available freshwater data revealed that 35% of the comparisons had significant differences ($p < 0.05$), with 80% of these, the Australasian species were the more sensitive. For the best available marine/estuarine water data, 47% of the comparisons showed significant differences ($p < 0.05$), with 60% of these, the non-Australasian organisms were more sensitive. Examination of the ratios of the differences between organisms from the two regions indicated that, as a whole, the freshwater Australasian species were significantly more sensitive while there were no significant differences ($p > 0.05$) detected between the marine/estuarine organisms.

SSDs could be derived for Cd, Cu and Zn in both fresh and marine/estuarine waters using acute toxicity data. Australasian freshwater organisms exposed to Cu were found to be significantly ($p<0.05$) more sensitive than the non-Australasian organisms. The five other comparisons showed no significant differences ($p > 0.05$). Estimated chronic trigger values (ECTVs) were derived using acute to chronic ratios. When comparing these ECTVs the Australasian organisms were found to be significantly more sensitive ($p < 0.05$) to Cu in freshwater, while the non-Australasian organisms were found to be significantly more sensitive ($p < 0.05$) to Cd in freshwater. The four other comparisons did not reveal any significant differences ($p > 0.05$).

Assessment factors were calculated using the ratio of the sensitivity of Australasian and non-Australasian species to the selected metals and then plotting the cumulative frequencies against the ratio. This analysis revealed that an assessment factor of 7.1 would need to be applied to protect 95% of Australasian organisms in freshwater ecosystems from 95% of chemicals studied, while an assessment factor of 2.2 would be needed to ensure that 95% of Australasian marine/estuarine organisms would be adequately protected from 95% of chemicals studied when using non-Australasian toxicity data to derive trigger values. The observed differences in sensitivity of Australasian and non-Australasian organisms to metals indicate that using non-Australasian data could cause either over or under protection of the local species and that this kind of study should be conducted with other chemical groups.